The Physical and Biochemical Properties of the Extracellular Matrix Regulate Cell Fate.

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Public Summary:
The extracellular matrix refers to all the proteins, sugars, and other molecules that surround and make up a cell's environment. Many of these components of the extracellular matrix are assembled by the cells themselves and play a key role in organizing cells into the different tissues that make up the body of an organism. Additionally, interactions between cells and matrix components can have significant effects on cell behavior, including stem cell differentiation, the process by which stem cells become a new cell type with more specialized function. In this review article, we discuss the various ways in which the extracellular matrix can affect stem cell differentiation and tissue development. The matrix can affect how cells communicate with each other, how they communicate with their environment, how they move around, and even how they are shaped. All of these are important for dictating how a cell will behave, and are thus critical for developing healthy tissues and organisms. By reviewing these mechanisms, we hope to provide a comprehensive view of the factors that will need to be controlled during the design of regenerative medicine therapies that utilize stem cells.

Scientific Abstract:
The extracellular matrix is a complex network of hydrated macromolecular proteins and sugars that, in concert with bound soluble factors, comprise the acellular stromal microenvironment of tissues. Rather than merely providing structural information to cells, the extracellular matrix plays an instructive role in development and is critical for the maintenance of tissue homeostasis. In this chapter, we review the composition of the extracellular matrix and summarize data illustrating its importance in embryogenesis, tissue-specific development, and stem cell differentiation. We discuss how the biophysical and biochemical properties of the extracellular matrix ligate specific transmembrane receptors to activate intracellular signaling that alter cell shape and cytoskeletal dynamics to modulate cell growth and viability, and direct cell migration and cell fate. We present examples describing how the extracellular matrix functions as a highly complex physical and chemical entity that regulates tissue organization and cell behavior through a dynamic and reciprocal dialogue with the cellular constituents of the tissue. We suggest that the extracellular matrix not only transmits cellular and tissue-level force to shape development and tune cellular activities that are key for coordinated tissue behavior, but that it is itself remodeled such that it temporally evolves to maintain the integrated function of the tissue. Accordingly, we argue that perturbations in extracellular matrix composition and structure compromise key developmental events and tissue homeostasis, and promote disease.